Time-Resolved Nonlinear Spectroscopy of Multiphase Materials

Project Number: 97-21

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Purpose

The objectives of this investigation are to apply time-resolved fluorescence and nonlinear spectroscopic techniques to the study of gravitationally sensitive multiphase materials. Specific goals are, 1) to apply fluorescence anisotropy to explore the dynamics of protein crystallization, and 2) to apply time-resolved nonlinear spectroscopy to determine how the presence of metal nanoparticles alters the effective optical properties of a material and to compare the results with theoretical predictions. The correlation between anisotropy and aggregation will be determined.

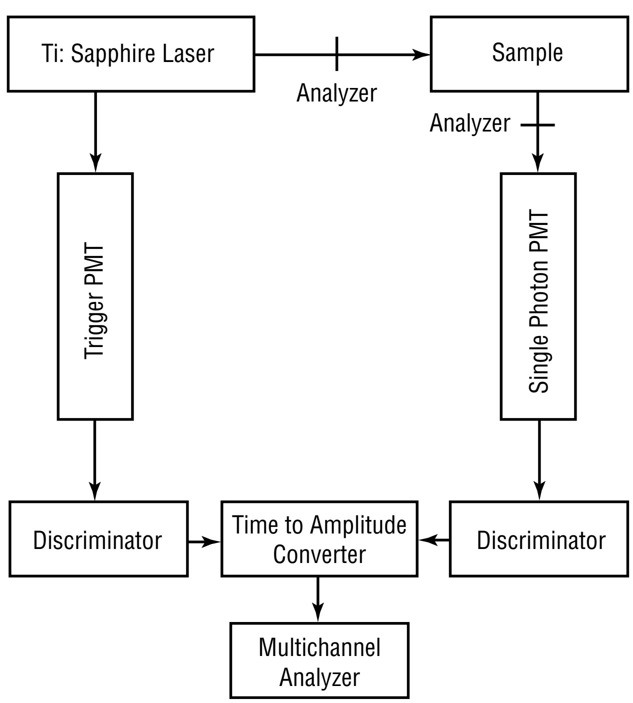

FIGURE 33.—Flourescence anisotropy.

Accomplishments

We have identified binding sites and derivatized lysozyme egg white protein with 10 different fluorophores; performed initial fluorescence anisotropy measurements at UTSI; and obtained polysilane from IBM Almaden Laboratory. We also have developed thiol-protected gold particles for incorporation into polymer hosts, and developed a theory to describe NLO behavior of metal/dielectric composites. Finally, we performed initial experiments at Alabama A&M University to verify our theory. Their laser was not sufficient for a full characterization but did confirm the theory.

Planned Future Work

- Investigate femtosecond dynamics of chromophore/protein systems. New work indicates a femtosecond component to solvent reorganization and Stokes shift.

- Select a fluorophore whose lifetime is comparable to the rotational diffusion time estimated from Stokes relationship or at least optimize the lifetime to diffusion time ratio to study different aggregate sizes. Correlate anisotropy with aggregation.

- Incorporate metal particles into polysilane. Determine if two-photon absorption is eliminated as predicted by our theory.

- Determine femtosecond NLO response of metal nanoparticle composites. The femtosecond response should be much different than the picosecond response due to interband transitions becoming dominant when thermal effects are avoided.

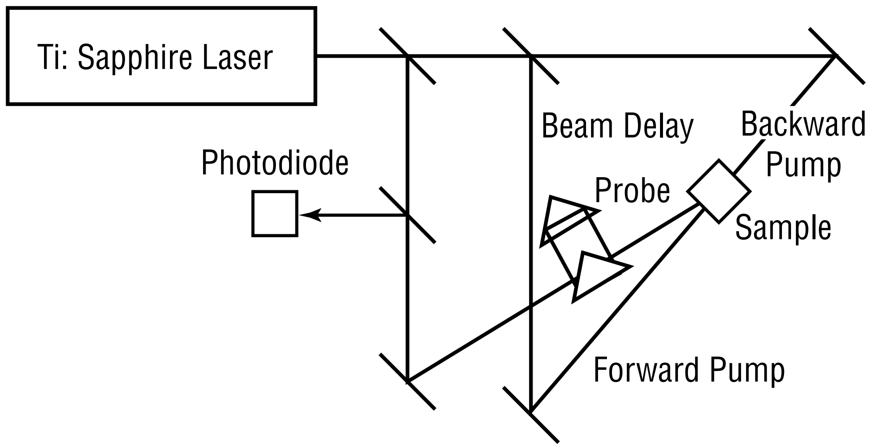

Figure 34.—Degenerate four wave mixing (DFWM).

Related Publications

Smith, D.D.; Gregory, D.A.; Fischer, G.; and Boyd, R.W.: "Optimization of Nonlinear Absorption and Refraction in Composite Optical Materials," Joint OSA/APS 12th Interdisciplinary Laser Science Conference (ILS–XII), Rochester, October 1996.

Smith, D.D.; Gregory, D.A.; Fischer, G.; and Boyd, R.W.: "Cancellation of Photo-Induced Absorption through a Counterintuitive Consequence of Local Field Effects in Metal Nanoparticle Composites," *Journal of the Optical Society of America B*, 14, 1625, July 1997.

Smith, D.D.; Sibille, L.; Cronise, R.; and Noever, D.A.: "Surface Plasmon Resonance Evaluation of Colloidal Silver Aerogel Filters," *Journal of Non-Crystalline Solids*, Accepted for Publication.

Smith, D.D.; Sibille, L.; Cronise, R.; and Noever, D.A.: "Surface Plasmon Resonance Evaluation of Colloidal Silver Aerogel Filters," Fifth International Symposium on Aerogels, Montpellier, France, September 1997.

Smith, D.D.; Gregory, D.A.; Fischer, G.; and Boyd, R.W.: "Towards a Figure of Merit for Composite Nonlinear Optical Materials," *Journal of Optical Society of America B*, Submitted.

Smith, D.D.; Bender, M.; Sarkisov, S.; Xiao, R-F.; and Boyd, R.W.: "Effects of Percolation on the Optical Nonlinearity of Metal Nanoparticle Composites," *Journal of the Optical Society of America B*, to be submitted.

Smith, D.D.; Sibille, L.; Cronise, R.; and Noever, D.A.: "Immersion Spectroscopy of Porous Media," *Journal of Porous Materials*, to be submitted.

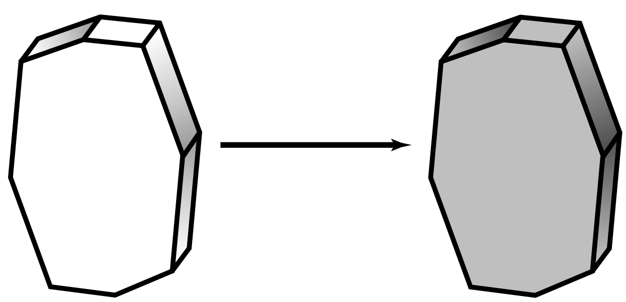

Figure 35.—Dye doped proteins.

Funding Summary ($k)

	FY97
Authorized:	78.5
Processed:	78.5
Balance:	0

Status of Investigation

Project approved—January 1997

Estimated completion—October 1998

Second year tasks will involve setting up the laser system, purchasing and integrating the electronics, and performing measurements on the samples, which are now prepared.